A PROTOTYPE TEST OF A MULTI-LEVEL MODEL FOR MILITARY-CIVILIAN MANPOWER PLANNING

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ABSTRACT

This report provides a small numerical example of a multi-level model which links a program planning sub-model with military and civilian manpower sub-models. The purpose of the examples is to provide a vehicle to begin to attack the policy and data issues surrounding this complex problem. The example is first limited to the manpower dynamics of military and civilian manpower planning. Once the computer solution for these sub-models is shown, a complete multi-level model is developed to include program planning goals. The computational results indicate that direct linkages between models of manpower dynamics and macro program planning are feasible.

Introduction

In a previous report[1/] we discussed a theoretical multi-level model for military-civilian manpower planning. In that report we sought to extend the dialogue necessary to consider models for studying military-civilian interactions. Now, we will proceed with a small numerical example of the multi-level model to begin to attack some of the policy and data issues.[2/]

The development of a small numerical example is an important stage in the Office of Civilian Manpower Management (OCMM) model development strategy. Initially, it allows the designers to check the computability of the model structure. More importantly, it provides a means of checking the model designs with potential users to determine if the outputs are in correspondence with their needs. Through this checking, the model design can be revised quickly and rechecked until it is sufficiently refined to fit the needs of the problem. In this way the users do not have to completely specify their information needs about which most likely they are not very sure about anyway. This process also gives considerable insight into the data and computer support needs in an efficient manner. Further, the model design process becomes self-correcting and self-implementing. The numerical example for our multi-level model should be viewed in the context of this research

1/ See A. Charnes, W. W. Cooper, and R. J. Niehaus [3]

2/ Research in this area is also being conducted by the Navy Personnel Research and Development Center under the auspices of their Manpower Requirements and Resources Control System (MARRCS) Project.

strategy. More than likely, parts of the problem will be incorrectly stated, incomplete or missing. However, it should provide a means of discussing the policy as well as data parameters of the problem.

Background.

Prior to a discussion of the details of the model, it would be well to look at the work force of the supporting naval shore establishment. This work force, excluding Marine Corps, contains approximately 300,000 civilian and 125,000 military personnel at activities employing civilians. Structurally, we find the shore installations to be either predominantly military. The large concentrations of military are at operational and training installations while the large concentrations of civilians are at maintenance, procurement, and research and development installations. This becomes clear when we look at the 82 largest shore installations employing civilians. They contain 235,000 or 70% of the civilian population and 14,500 or 2.5% of the military population. Additionally, if we restrict ourselves to installations with more than 2,000 civilians, we find only one installation with a sizable military population, two with 300-400 military, and the rest with generally less than 150 military. Table 1 provides a breakdown of the relationship of activity size and the military and civilian workforce.

Changes in the size of the Navy's civilian workforce are much more likely dependent on such variables as the size of the active fleet and aircraft squadrons and on future procurements than on military manning levels. At the shore installation level the models in most cases should

Table 1

Distribution by Size of Civilians and Military

In The U. S. Navy

Summary for Dec 1972

Size of Activity (By No. of Civilians)	No. of Activities	Total Civilians	% of Civ. Workforce	Total Navy Military	% of Navy Mil. Workforce
Employing Civilians:					
1,000 - 50,000	82	233,296	69.4%	14,479	2.5%
501 - 1,000	52	36,332	10.8%	16,236	2.8%
101 - 500	206	49,115	14.6%	39,985	6.9%
51 - 100	135	9,755	2.9%	14,524	2.5%
26 - 50	114	4,373	1.3%	12,929	2.2%
11 - 25	142	2,355	0.7%	10,943	1.9%
1 - 10	257	1,180	0.3%	16,499	2.8%
Subtotal	988	336,406	100%	125,595	21.6%
OTHER:	---	---	---	456,279	78.4%
TOTALS		336,406	100%	581,874	100%

either be heavily military or heavily civilian oriented. The critical part of the workforce (e.g., scientists and engineers in the laboratories or military manpower in a large training installation) should be given the predominance in the model structure. Also, military-civilian models should be concerned with the dynamics of assignment planning. It is most likely sufficient to restrict the development of military-civilian requirements and control models to the aggregate program planning process. The models we will discuss in the next sections of this paper are being suggested with that end in mind.

The most difficult part of the military-civilian planning task is to insure compatibility between macro program planning at the Navy-wide level and micro requirement planning at the local level. This becomes an easier task if the planning follows the assumption that military manpower requirements should drive the system to avoid denigration of readiness because of manpower. That is, military manpower requirements should be determined first and then balanced with the total manpower required at the local level.3/ A combination of a "top down" and "bottoms up" strategy is needed. From the top should come down the military requirements and civilian end strength targets. These data then become guidance to be considered in balancing the local workload to available resources. Conversely, after the first iteration, local workload requirements should be used to make any necessary changes in the program requirements. Thus,

3/ The Navy, under the direction of the Chief of Naval Operations has in development a project called Shore Requirements, Standards, and Manpower Planning System (SHORSTAMPS) to specifically address the problem of obtaining better military-civilian manpower requirements data.

considerable intimate involvement of the line manager (the user of the manpower) in manpower requirements planning process is needed to obtain the benefits of any computer-assisted modelling system.4/

The multi-level modelling system we proposed in [3] is designed to provide an integrated approach to program planning which includes the dynamics of the manpower requirements-inventory relationships of mixed military-civilian manpower systems. It could be used to assist in evaluating the structure of total internal manpower requirements for changing task arrangements, in testing of policy alternatives as changes occur in the budgeting process, and for planning for orderly recruitment or retrenchment over time. As a by-product data could also be obtained on the projected short-falls or overages resulting from the budgetary allocation process.

This multi-level model builds upon and extends the current Navy Requirements Model (NARM). It is a dynamic system providing for the relationship of the current and projected overages and underages of manpower and thus the relationship of the changes of one period's program requirements on another. The multi-level model provides explicitly for any discrepancies in meeting manpower

4/ See W. N. Price [9] for a discussion of the roles of the military-civilian team.

and program requirements. Policy officials can then test to determine the resultant programming of men and dollars which will permit the intended programs to be effected and developed. This multi-level model builds upon the structure and data system already in existence and use within the Navy. No large-scale changes are needed in management terminology or organizational arrangements in order to begin testing the applicability of the model.

The next step following the technical and management review of the numerical example would be to begin testing a portion of the model with live problems. Some of this has already been started using the civilian ceiling and budget control problem.[5/] Rather than discuss this application, let us turn to numerical examples which show the dimensions of the proposed model.

5/ This model is being constructed through use of the Computer-Assisted Manpower Analysis System (CAMAS) of OCMM. It is a short range planning model to evaluate quarterly ceiling and budget constraints in light of projected attrition.

Manpower Dynamics

The multi-level model as discussed in [3] includes a program planning sub-model linked to a military manpower sub-model and a civilian manpower sub-model. For the moment we will limit our discussion to numerical examples of the manpower sub-models.

The military sub-model structure should be viewed as a first attempt to include military manpower in a goal programming model with embedded Markov processes.[6] The testing of the theoretical mathematics as discussed in [3] for including planned rotation dates in the model were not included in this first numerical example. The purpose here was to include some of the aspects of military manpower planning as far as the complete multi-level model is concerned. The military sub-model in later designs in all likelihood could include the model suggested in Appendix A of [3] or some other mathematical programming model which is consistent with the multi-level model system.[7]

The civilian sub-model is a version of the OCMM Recruiting Requirements Model (ORRM) which is already being applied to a number of operational

6/ See D. J. Clough, R. C. Dudding, and W. L. Price [5] for a description of the first attempts to use goal programming for planning in the Canadian armed forces.

7/ See R. C. Grinold, K. T. Marshall and R. M. Oliver [7] for a description of a mathematical programming model for military manpower planning which is being tested by the Office of the Deputy Chief of Naval Operations (Manpower and Naval Reserve).

uses.[8/] These are included as part of the Computer-Assisted Manpower Analyses System (CAMAS) which is a large-scale generalized system to support civilian manpower and personnel model applications at all levels within the Navy. For purposes of this paper we will restrict ourselves to a small numerical example in order to maintain consistancy in the exposition of the multi-level model.

A comprehensive description of the manpower sub-models was given in [3]. Figure 1 shows both the military and civilian sub-models as part of one user organization. For example, this user organization could be a program area or large shore installation. Both the military and civilian sub-models are of the goal programming variety. The objective of the models is to come "as close as possible" to the manpower requirements goals subject to various manpower strength and budgetary constraints.

The military sub-model in Figure 1 depicts the fact that changes in the manpower inventories as well as changes in manpower requirements are addressed in the same system. Management and fiscal constraints in terms of end strength controls and the military manpower budget are also considered. Strict military requirements can also be incorporated in this model by means of lower bounds on the individual manpower requirements. In the civilian sub-model, similar processes are involved. Contracting possibilities are also included since part of all of the manpower shortages might be able to be accommodated by any excess civilian salary funding which is indicated explicitly in the model solutions.[9/]

8/ See [2], [4], [6], and [8] for descriptions of some of the applications of ORRM which have been tested using operational data.

9/ Currently, military manpower dollars cannot be traded if shortfalls exist in general operating or revolving fund dollars.

INTEGRATED MILITARY-CIVILIAN MANPOWER MODEL

		MILITARY MANPOWER					CIVILIAN MANPOWER						
		POSITIVE GOAL DISCREP.	NEGATIVE GOAL DISCREP.	ON-BOARD MILITARY MANPOWER	NEW MILITARY RECRUITS	RELEASE FROM ACTIVE DUTY	POSITIVE GOAL DISCREP.	NEGATIVE GOAL DISCREP.	ON-BOARD CIVILIAN MANPOWER	NEW HIRE MANPOWER	EXCESS MANPOWER	SIGN	RHS
RELATIVE PRIORITIES		λ	λ		μ	ν	β	β		γ	δ		
MILITARY SUB-MODEL	MANPOWER GOALS	-I -I	I I	I I								= =	MILITARY MANPOWER REQUIREMENTS
	MANPOWER ATTRITION			I -M I -M I	-I -I	I I						= = =	INITIAL MIL POP 0 0
	MILITARY ONLY REQUIREMENTS			e^T e^T								= =	PURELY MILITARY REQUIREMENTS
	TOTAL BILLET CONSTRAINTS			e^T e^T								≤ ≤	TOTAL BILLETS AVAILABLE
	MIL. BUDGET CONSTRAINTS			ms^T ms^T								≤ ≤	MILITARY PERSONNEL BUDGET
CIVILIAN SUB-MODEL	MANPOWER GOALS						-I -I	I I				= =	CIVILIAN MANPOWER REQUIREMENTS
	MANPOWER ATTRITION								I -C I -C I	-I -I	I I	= = =	INITIAL CIV POP 0 0
	TOTAL MANPOWER CONSTRAINTS								e^T e^T			≤ ≤	CIVILIAN MANPOWER AVAILABLE
	SALARY BUDGET CONSTRAINTS								cs^T cs^T			≤ ≤	CIVILIAN SALARY BUDGET
OCCUPATION SUBSTITUTION				e^T e^T					e^T e^T			≥ ≥	OCCUPATIONAL LOWER BOUNDS

KEY:

- I = Identity Matrix
- M = Military Transition Matrix
- e^T = (1,...,1)
- ms^T = Transpose of military salary vector
- C = Civilian Transition Matrix
- cs^T = Transpose of Civilian Salary Vector

FIGURE 1.

The model can be bound together by total force constraints. One cannot, however, always substitute military for civilians and vice versa. For example, an officer cannot be substituted for a civilian ungraded employee. In fact, union opposition normally would make it inadvisable to transfer military personnel to ungraded civilian positions. Thus, large blocks of civilian positions are not structured to permit substitution by military billets. In any event, even at this level of abstraction, it is clear that military-civilian substitutions must be occupationally based. This strengthens the argument that military requirements should be planned first and civilian and contractor manpower used to supplement these requirements.

In our numerical example, we allow substitutions only between officers and civilian professionals, and between enlisted and civilian technicians. The occupational substitution constraint is put into the model as a lower bound. This ensures that least a minimum level of skill is maintained. All of this leads to an assignment planning system which is embedded in the task required to be performed by the Navy. Our numerical example has already helped to surface many of the issues wrapped up in this complex problem. Let us leave these issues for the moment and develop a computational example of the manpower dynamics portion of our multi-level model.

The data used in the manpower sub-models of our multi-level model numerical example are given in Tables 2 and 3. In the full example, two program areas are used with manpower by Officer, Enlisted, Civilian, Professional, and Civilian Technicians. [10/] The manpower requirements and constraints data by program area are given in Table 2 and the manpower system constraints data are given in Table 3.

10/ In an operational model these categories could be extended to include occupational and job level distinctions.

MULTI-LEVEL MILITARY CIVILIAN MODEL
NUMERICAL EXAMPLE
MANPOWER REQUIREMENTS AND CONSTRAINTS
BY PROGRAM AREA

MILITARY MANPOWER

	INITIAL POPULATION		REQUIREMENTS YEAR 1		REQUIREMENTS YEAR 2	
PROGRAM AREA	OFFICER	ENLISTED	OFFICER	ENLISTED	OFFICER	ENLISTED
1	100	225	100	215	95	200
2	250	1050	250	1050	225	1000
TOTALS	350	1275	350	1265	320	1200

CIVILIAN MANPOWER

	INITIAL POPULATION		REQUIREMENTS YEAR 1		REQUIREMENTS YEAR 2	
PROGRAM AREA	PROFESSIONAL	TECHNICIANS	PROFESSIONAL	TECHNICIANS	PROFESSIONAL	TECHNICIANS
1	6000	6500	6500	7000	6300	6800
2	10000	15000	9500	14000	9000	13000
TOTALS	16000	21500	16000	21000	15300	19800

STRENGTH AND BUDGETARY CONSTRAINTS

	CIVILIAN END-STRENGTH		CIVILIAN SALARY BUDGET (Millions)		STRICT MILITARY REQUIREMENTS YEAR 1		STRICT MILITARY REQUIREMENTS YEAR 2	
PROGRAM AREA	PERIOD 1	PERIOD 2	PERIOD 1	PERIOD 2	OFFICER	ENLISTED	OFFICER	ENLISTED
1	15000	24000	185	320	90	175	90	175
2	15000	22500	175	300	225	945	200	900

AVERAGE SALARY (000's)

	YEAR 1 MILITARY		YEAR 1 CIVILIAN		YEAR 2 MILITARY		YEAR 2 CIVILIAN	
PROGRAM AREA	OFFICER	ENLISTED	PROFESSIONAL	TECHNICIAN	OFFICER	ENLISTED	PROFESSIONAL	TECHNICIAN
1	18.0	10.0	16.5	10.0	18.0	10.0	16.5	10.0
2	18.0	10.0	17.0	10.5	18.0	10.0	17.0	10.5

TABLE 2.

MULTI-LEVEL MILITARY-CIVILIAN MODEL
NUMERICAL EXAMPLE
MANPOWER SYSTEM CONSTRAINTS

	YEAR 1		YEAR 2	
TYPE	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
OFFICER	315	375	290	360
ENLISTED	1,150	1,400	1,120	1,375
PROFESSIONAL	14,714		14,057	
TECHNICIAN	20,028		18,900	

NOTE: Professional = Officer and Civilian Professionals

Technicians = Enlisted and Civilian Technicians

MILITARY PAY
(Millions)

PERIOD 1	PERIOD 2
25.0	25.0

RELATIVE PRIORITIES
(Penalty Weights)

Hiring	1	Deficiency	2
Firing	3	Excess	2

MILITARY TRANSITION RATES
(Read Across)

	OFFICER	ENLISTED
OFFICER	.75	
ENLISTED		.50

CIVILIAN TRANSITION RATES
(Read Across)

	PROFESSIONAL	TECHNICIAN
PROFESSIONAL	.80	.10
TECHNICIAN	.15	.70

TABLE 3.

MULTI-LEVEL MILITARY CIVILIAN MODEL
NUMERICAL EXAMPLE-PROBLEM AREA A
MANPOWER SUB-MODEL SEPARATELY

SOLUTION DATA

PROJECTED ON-BOARD YEAR 1

CATEGORY	ABOARD	HIRES	FIRES	GOAL	DISCREPANCY	LIMITS	
OFFICER	100	25		100		100	100
ENLISTED	215	103		215		215	215
CIV PROF	6,500	725		6,500			
CIV TECH	7,000	1,850		7,000			

PROJECTED ON-BOARD YEAR 2

CATEGORY	ABOARD	HIRES	FIRES	GOAL	DISCREPANCY	LIMITS	
OFFICER	95	20		95		95	95
ENLISTED	200	93		200		200	200
CIV PROF	6,250			6,300	- 50		
CIV TECH	6,548	998		6,800	-252		

BUDGETS (Million $)

	MILITARY		CIVILIAN	
	ACTUAL	MAXIMUM	ACTUAL	MAXIMUM
YEAR 1	3.95	4.80	177.25	185.00
YEAR 2	3.71	4.60	175.00	175.00

CIVILIAN CEILING

	ACTUAL	MAXIMUM
YEAR 1	13,500	15,000
YEAR 2	12,798	15,000

TABLE 4.

For purposes of exposition of the manpower dynamics portion of the model, only Program Area 1 was used. The data for Program Area 1 were coded for solution by FMPS - The UNIVAC 1108 linear programming language. This resulted in a model with 39 equations and 44 variables.

The solution of the numerical example of the manpower dynamics of Program Area 1 are given in Table 4. Less than 10 seconds of computer time were used. This shows that computer solution of a model of this type is computationally possible. Further, it showed that it was realistic to consider constructing the complete example of the multi-level model discussed in the next section of this paper.

Integration with Program Planning

Manpower requirements data should be developed directly as part of the workload or program planning process. In the aggregate, this is done in the Navy by the Program Planning Office of the Chief of Naval Operations. In recent years, considerable assistance to this process has been obtained through use of the Navy Requirements Model (NARM). This is an input-output model originally developed by the Center for Naval Analyses (CNA).11/

The development of our multi-level model as discussed in [2] and [3]; began with an extensive information sharing arrangement with the NARM developers. The current structure of our model would use many of the coefficients developed during the budget process as a result of the use of the NARM. A version of this model is included in the CAMAS software. However, these software subroutines have never been tested using an operational problem.

11/ See J. H. Augusta and G. W. Ryhanych [1] for a discussion of the original developmental efforts which led to the NARM.

The basic structural ideas of the multi-level model can be obtained in [3]. These have been modified to some extent as a result of the testing the numerical example. The model remains a goal programming model with three sets of goal equations (i.e., program goals, military manpower goals, and civilian manpower goals). The output of the model continues to be an explicit calculation of the discrepancies from those goals considering the constraints and relative priorities used.

Figure 2 shows the structure of our numerical example. In this case, we have one user and two producers of final services. For example, the user might be the fleet and the producers might be two major shore installations. Each of the Program Areas in our numerical example has both military and civilian manpower included. Thus, we have two models such as was discussed in the last section of the report tied together with a third model to incorporate the program planning.

The program related data used in the input-output portion of the numerical example are given in Table 5. The manpower per dollar ratios used to couple the manpower sub-models to the program planning model are included. In this example, it was assumed that military and civilian manpower were convertible as far as productivity is concerned. Thus, the same manpower per dollar ratio were used for military as well as civilian manpower. This assumption merits further study although it will be difficult in many instances to prove otherwise.

The complete model which was constructed contained 87 equations and 98 variables. Solution of the linear program was obtained in less than 20 seconds of UNIVAC 1108 CPU time. The results are given in Tables 6-8. Thus, the complete multi-level model system appears computationally

MULTI-LEVEL GOAL PROGRAMMING MODEL
FOR TOTAL FORCES PLANNING
5 APRIL 1974

RELATIVE PRIORITIES						RHS
PROGRAM PLANNING MODEL	USER/PRODUCER INPUT-OUTPUT MODEL					FINAL USER GOALS AND PRODUCER BUDGETS
MANPOWER/DOLLAR RELATIONSHIPS	$M/\$_A$ $M/\$_N$	-I		-I	= =	0 0
PROJECT A MODEL		PROJECT A MILITARY-CIVILIAN MANPOWER MODEL				PROJECT A MANPOWER GOALS AND CONSTRAINTS
0 0 0			0 0 0			0 0 0
PROJECT N MODEL				PROJECT N MILITARY-CIVILIAN MANPOWER MODEL		PROJECT N MAN-POWER GOALS AND CONSTRAINTS
OCCUPATIONAL SUBSTITUTION RELATIONSHIPS		I I		I I	$\geq$ $\geq$	OCCUPATION CATEGORY LOWER BOUNDS
TOTAL FORCE CONSTRAINTS		e^T_A		e^T_N	$\leq$	TOTAL MANPOWER SPACES

FIGURE 2

MULTI-LEVEL MILITARY-CIVILIAN MODEL
NUMERICAL EXAMPLE
PROGRAM PLANNING DATA

HISTORICAL INPUT-OUTPUT DATA
BUDGET (in millions)

	PROGRAM AREA 1	PROGRAM AREA 2	FLEET SUPPORT	TOTALS	I/O RATE
PROGRAM AREA 1	90	50	185	325	0.562308
PROGRAM AREA 2	40	210	300	550	0.545455
TOTALS	130	260	485	875	

HISTORICAL MANPOWER DATA

	PROGRAM AREA 1	PROGRAM AREA 2
MILITARY	335	1,300
CIVILIAN	12,500	25,000
TOTALS	12,835	26,300
MANPOWER/MILLION $	39.492	47.818

PROJECTED PROGRAM REQUIREMENTS

	PROGRAM AREA 1	PROGRAM AREA 2	TOTAL FLEET SUPPORT
YEAR 1	335	540	475
YEAR 2	330	535	475

TABLE 5.

MULTI-LEVEL MILITARY-CIVILIAN MODEL
NUMERICAL EXAMPLE
PROGRAM PLANNING SOLUTION DATA

TOTAL FLEET SUPPORT
(Millions $)

	ACTUAL	GOAL	DISCREPANCY	LIMITS	
YEAR 1	475.00	475.00		400.00	550.00
YEAR 2	458.98	475.00	16.02	400.00	550.00

PROGRAM AREA RESOURCE USAGE

	AVAILABLE	USED	UNUSED
YEAR 1			
Program Area A	335.00	335.00	
Program Area B	540.00	525.48	14.52
YEAR 2			
Program Area A	330.00	330.00	
Program Area B	535.00	501.28	33.72

TABLE 6.

MULTI-LEVEL MILITARY-CIVILIAN MODEL
NUMERICAL EXAMPLE
MANPOWER SUB-MODELS SOLUTION DATA

PROJECTED ON-BOARD YEAR 1:

CATEGORY	ABOARD	HIRES	FIRES	GOAL	DISCREPANCY	LIMITS
Program Area A						
Officer	90	15		100	-10	90
Enlisted	175	63		215	-40	175
Civ Professional	6,500	725		6,500		
Civ Technical	6,465	1,315		7,000	-535	
Program Area B						
Officer	250	63		250		250
Enlisted	1,050	525		1,050		1,050
Civ Professional	9,828		422	9,500	+328	
Civ Technical	14,000	2,500		14,000		

PROJECTED ON-BOARD YEAR 2:

CATEGORY	ABOARD	HIRES	FIRES	GOAL	DISCREPANCY	LIMITS
Program Area A						
Officer	90	23		95	-5	90
Enlisted	175	88		200	-25	175
Civ Professional	6,299	129		6,300	-1	
Civ Technical	6,468	1,293		6,800	-332	
Program Area B						
Officer	270	83		270		270
Enlisted	1,200	675		1,200		1,200
Civ Professional	9,500		462	9,000	+500	
Civ Technical	13,000	2,217		13,000		

OCCUPATIONAL STRENGTH DATA

	ACTUAL	MINIMUM
YEAR 1		
Professional*	16,668	14,714
Technician	21,690	20,028
YEAR 2		
Professional	16,159	14,057
Technician	20,843	18,900

*Professional = Officer and Civilian Professional
Technician = Enlisted and Civilian Technical

TABLE.7.

MULTI-LEVEL MILITARY-CIVILIAN MODEL
NUMERICAL EXAMPLE
MANPOWER SUB-MODELS SOLUTION DATA

CIVILIAN SALARY BUDGET
(Millions $)

	PROGRAM AREA A		PROGRAM AREA B	
	ACTUAL	MAXIMUM	ACTUAL	MAXIMUM
YEAR 1	171.90	185.00	302.15	320.00
YEAR 2	175.00	175.00	298.00	300.00

CIVILIAN CEILING

	PROGRAM AREA A		PROGRAM AREA B	
	ACTUAL	MAXIMUM	ACTUAL	MAXIMUM
YEAR 1	12,965	15,000	23,828	24,000
YEAR 2	12,767	15,000	22,500	22,500

MILITARY SALARY BUDGET
TOTAL SYSTEM
(Millions $)

	ACTUAL	MAXIMUM
YEAR 1	18.37	25.00
YEAR 2	20.23	25.00

MILITARY STRENGTH
TOTAL SYSTEM

	ON-BOARD	LIMITS	
YEAR 1			
Officer	340	315	375
Enlisted	1,225	1,150	1,400
YEAR 2			
Officer	360	290	360
Enlisted	1,375	1,120	1,375

TABLE 8.

feasible. Also, operational versions should be able to be solved on a computer in realistic processing times.

Conclusions and Future Research

A number of the issues concerned with the integration of military-civilian manpower planning have been discussed. This was done in the context of a small numerical prototype of a multi-level model. These results indicate that military-civilian manpower planning beyond the aggregate program planning process must be occupationally based. Even here there are many restrictions due to administrative and legal constraints which make modelling of the process difficult. It appears that modelling should be restricted to (a) the macro program planning process; (b) specific professional and technical skill areas; and (c) local installations that have a mixture of a large number of military personnel and a large number of civilian personnel.

The computational results indicate that direct linkages between models of manpower dynamics and macro program planning are feasible. In particular, the use of data developed for support of the Navy Requirement Model (NARM) might be used in a goal programming context. This would make the interdependencies in the NARM less rigid. This result is particularly important for modelling the civilian manpower inputs which are normally developed after the military force levels have been determined.

Additional research would be fruitful in examining the relationship of manpower dynamics to program planning. An important next step would be to construct an operational prototype to determine the problems and possibilities of the multi-level models to assist in this decision process. Most likely

this should be done restricting the prototype of the integration of civilian manpower dynamics with program planning. In this case the computer software support system is in place as the civilian manpower models have already undergone rigorous operational testing.

We have shown some of the dimensions of the problems of developing a system of models to assist in military-civilian manpower planning. Additionally, we have provided a possible means of resolving them. A considerable amount of research remains to be done, however, prior to the application of this model to large-scale problems.

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13. ABSTRACT

This report provides a small numerical example of a multi-level model which links a program planning sub-model with military and civilian manpower sub-models. The purpose of the examples is to provide a vehicle to begin to attack the policy and data issues surrounding this complex problem. The example is first limited to the manpower dynamics of military and civilian manpower planning. Once the computer solution for these sub-models is shown, a complete multi-level model is developed to include program planning goals. The computational results indicate that direct linkages between models of manpower dynamics and macroprogram planning are feasible.

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